A MULTIVARIATE PROCESS MODEL TO EVALUATE UNDERGRADUATE PHYSICAL THERAPY STUDENTS ADMITTED BY STRATIFIED SAMPLE AND BY ORDINAL RANK PRE-SELECTION

By

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TABLE OF CONTENTS

		Page
ACKNOWLEDGMENTS		ii
LIST OF TABLES		vii
ABSTRACT		viii
CHAPTER		
I	INTRODUCTION	1
	General Background	1
	Statement of the Problem	4
	Need for the Study	5
	Basic Assumptions	7
	Limitations of the Study	7
	Delimitations of the Study	7
	Definition of Terms	8
II	REVIEW OF THE LITERATURE	11
	The 1950-52 Physical Therapy Research Study	11
	The Admission Procedure	13
	Committee and Actuarial Methods	14
	Changing Concepts in the Admission Procedure	16
	Use of the Computer in Admissions	20
	The Q-Sort Technique	21
	Predictor Variables	22
	Cognitive Factors	22

Page

Non-Cognitive Factors. 27

Interest. 27

Personality 29

The interview 30

Biographical inventory. 32

Other factors 35

Grades as Criteria Variables. 36

III RESEARCH DESIGN AND PROCEDURES. 40

Subjects. 40

Method of Data Collection 41

Data Analysis 42

IV RESULTS, ANALYSIS OF DATA, AND THE PROCESS MODEL. 44

Introduction. 44

1. t Test--Comparison of the 1977 and 1978 Groups, Five Predictor Variables and One Criterion Variable. 45

2. Stepwise Discriminant Analysis--Group Affiliations for 1978 Test Group: Pre-Selected and Stratified Sample. 47

Predictor Variable Analysis. 48

First Year Grade Analysis. 52

3. Stepwise Multiple Regression. 55

A Formula to Predict Grade Point Average, First Year Physical Therapy Curriculum, 1977-1978 Data 55

Cross-Validation 56

4. t Test--Comparison Between Pre-Selected and Stratified Sample Groups, 1978, with Three Criteria Variables 60

5. The Stratified Sample Process Model 62

Page

Stratified Sample Process Model Criteria 62

Application of the Stratified Sample Process Model. 62

V SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS 68

Summary 68

Conclusions 72

Recommendations 73

APPENDICES

A COMPUTER CARD DATA CODING 77

B EXAMPLES OF DECK SETUP, SPSS PROGRAM. 79

t Test. 79

Discriminant Analysis 80

Multiple Regression Analysis. 81

Cross-Validation for Multiple Regression Analysis 81

BIBLIOGRAPHY 82

BIOGRAPHICAL SKETCH. 88

LIST OF TABLES

Table		Page
1	t TEST VALUES ON GROUP DIFFERENCES OF SCAT TOTAL, PRE-OVERALL GPA, PRE-PROFESSIONAL GPA, ZOOLOGY GPA, PATIENT POINTS, AND FIRST YEAR GPA, P.T. FOR 1977 AND 1978 CLASSES.	46
2	INCLUSION OF VARIABLES, BY STEP, PREDICTOR VARIABLE ANALYSIS, 1978 CLASS	50
3	COMPARISON OF ACTUAL GROUP MEMBERSHIP WITH PREDICTED GROUP MEMBERSHIP, PREDICTOR VARIABLE ANALYSIS, 1978 CLASS.	50
4	COMPARISON OF GROUP MEANS BETWEEN PRE-SELECTED AND STRATIFIED SAMPLE GROUPS; AND UNIVARIATE F RATIO OF PREDICTOR VARIABLES, 1978 CLASS.	51
5	INCLUSION OF VARIABLES, BY STEP, FIRST YEAR GRADES, 1978 CLASS	51
6	COMPARISON OF ACTUAL GROUP MEMBERSHIP WITH PREDICTED GROUP MEMBERSHIP, FIRST YEAR GRADES, 1978 CLASS.	53
7	COMPARISON OF GROUP MEANS BETWEEN PRE-SELECTED AND STRATIFIED SAMPLE GROUPS; AND UNIVARIATE F RATIO OF FIRST YEAR GRADES, 1978 CLASS.	54
8	INCLUSION OF VARIABLES, BY STEP, 1977-1978 CLASSES, MULTIPLE REGRESSION ANALYSIS	57
9	MULTIPLE REGRESSION STATISTICS, PRE-OVERALL GPA, WITH FIRST YEAR GPA, 1977-1978 CLASSES.	57
10	MEAN, STANDARD DEVIATION, AND CORRELATION MATRIX OF VARIABLES, 1977-1978 CLASSES, MULTIPLE REGRESSION ANALYSIS	59
11	MULTIPLE REGRESSION STATISTICS, PRE-OVERALL GPA, 1977 YEAR, AND GPA*YEAR WITH FIRST YEAR GPA, 1977 CLASS	59
12	t TEST VALUES, GROUP DIFFERENCES OF FIRST, SECOND, AND THIRD QUARTER GPA, P.T., FOR PRE-SELECTED AND STRATIFIED SAMPLE GROUPS, 1978 CLASS.	61

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A MULTIVARIATE PROCESS MODEL TO EVALUATE UNDERGRADUATE PHYSICAL THERAPY STUDENTS ADMITTED BY STRATIFIED SAMPLE AND BY ORDINAL RANK PRE-SELECTION

By

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This study had two purposes. The first was to determine whether a first year class of physical therapy students partially selected by stratified sampling was comparable to the remainder of the same class chosen by ordinal rank pre-selection, using established predictor variables. The second purpose was to develop a process model which could be used to evaluate future data of a similar type as well as to improve the predictor variables if changes in these variables were necessary to improve the selection process involving stratified sampling.

The study leading to the development of the process model utilized stepwise discriminant analysis, stepwise multiple regression, and the t test. The 1977 class was selected solely by ordinal rank pre-selection. The 1978 class was partially selected by ordinal rank pre-selection and selected partially by stratified sampling from a pool of qualified applicants.

The t test procedure was used to compare the 1977 and 1978 classes. The t test was also used for trend analysis during the first year of the physical therapy program between the pre-selected and stratified sample

groups for the 1978 class. Results of the group comparison of five predictor variables and first year grade point average between the 1977 and 1978 classes showed no significant differences, indicating the comparability of the two classes. Analyses of the first, second, and third quarter grade point averages between the pre-selected and stratified sample groups indicated a significant difference in the first and second quarter grade point averages, with no significant difference in the third quarter. The trend of similar academic performance in the third quarter was verified with the discriminant analysis.

Two analyses for group affiliation were conducted using discriminant analysis. In the analysis of seven predictor variables with group affiliation, the overall grade point average prior to admission (the pre-overall GPA) was the most powerful of the predictor variables in the discriminant function. In the sample tested, a significant cumulative F ratio included four of the seven predictor variables. The prediction equation using the four variables correctly classified 85.7 per cent of the students who were admitted by the pre-selection criteria and 81.8 per cent of the students who were admitted through stratified sampling. The combined prediction accuracy of both equations for the total sample was 84.0 per cent.

In the analysis of eleven variables, grades achieved during the first year in physical therapy, two grades were significant in group discrimination. The grades were in Basic Anatomy and Physiology taught during the first quarter and the Nervous System taught in the second quarter. In the sample that was tested, a significant cumulative F ratio included three of the eleven variables. The prediction equation using the three

variables correctly classified 71.4 per cent of the students who were admitted by pre-selection, and 90.9 per cent of the students who were admitted by stratified sample. The combined prediction accuracy of both equations was 80.0 per cent.

Using data from the 1977 and 1978 classes, a formula to predict first year grade point average was developed using a stepwise multiple regression Statistical Package for the Social Sciences (SPSS) computer program. The only significant F ratio was the overall grade point average for the first two years of college. The other variables were of marginal value. A cross-validation with the 1977 year indicated valid predictability for performance in the curriculum using the overall grade point average prior to selection as the sole predictor variable.

A process model was developed based on the data for two undergraduate physical therapy classes at the University of Florida, the 1977 and 1978 graduating classes. The model was designed to enable physical therapy admission personnel to select and analyze applicants, who in part were admitted by stratified sampling from a larger pool of equally qualified applicants.

The study suggested more similarities than differences between the pre-selected and stratified sample groups in their achievement during the first year in the physical therapy program. It also demonstrated that a process model could be developed with the data presented, and that stratified sampling was a possible consideration for admitting physical therapy students. Further research should be considered for testing the reliability and validity of the study.

CHAPTER I

INTRODUCTION

General Background

The concept of stratified sampling in the admission procedure, or as it is often referred to in lay and professional literature--lottery or lot--is not new. However, the implementation, as reported in this dissertation, is an important new step in the admission process.

The admission procedure should be fair to two parties--the institution admitting the student and the student being admitted. The institution, through the admission procedure, selects the student who has a minimum chance of failure in required academic work and, in the case of the health professions, has the potential to work with patients. The student seeks admission to a chosen curriculum, and does not want to be denied admission for reasons the applicant does not understand, or deems to be unfair. The good admission procedure reconciles both points of view.

The institution receiving many more basically qualified applicants than there are places in the entering class may find it difficult to reconcile both pressures. Most use specific admission criteria, or from a statistical perspective predictor variables, to choose applicants to be admitted. The use of a weighted formula to select applicants is a common practice. The applicants with the best qualifications provide the requisite number of admissions for any given class. This results in

students being denied admission, who could be admitted if more places were available in the entering class. To compensate for this, the student applies to a number of schools offering similar courses of study. The applicant does this in the hope of qualifying in at least one of the schools. From the student's action, the applicant is in effect using a modified stratified selection process.

Funkenstein (1970), in discussing an improved plan to admit applicants to medical school, recommended:

> After the applicants who are clearly superior to the others . . . have been accepted, those clearly presenting less adequate qualifications have been rejected, and the various claims for admission such as geography, alumni children, etc. are satisfied, a large number of students who are highly qualified to become physicians are left. If enough places were available in the nation's medical schools, they could become excellent physicians. It is impossible to distinguish among them by any objective criteria. Under these circumstances, the only fair way to deal with them would be to select by lottery among them for acceptance into the remaining places in a class. (p. 505)

Some of the advantages stated in the literature for stratified sampling were that it could save a significant amount of time and effort for all concerned; the principle of equality could be served (Kurland 1968); and that it substituted overt randomization for covert randomization, eliminated unwarrantable prejudices and biases, and did away with the numerical guessing game (Simpson 1975). Other advantages indicated were that by including subpools of desired characteristics into a larger pool from which stratified sampling took place, a better distribution was assured of candidates with certain desirable characteristics other than

intellectual factors (Kurland 1968); and selection errors attributed to characteristics of the applicants or selectors were reduced (Chaisson 1976).

Some of the disadvantages of stratified sampling stated by Kurland (1968) were

> Objections to the use of the lot in the allocation of educational opportunities may be based on the moral objection to any form of gambling, or an aesthetic revulsion to leaving to chance such important matters, on the philosophical ground that matters theoretically amenable to rational solution ought not to be left to chance solution, on the educational ground that it will lessen achievement motivation. (p. 223)

Other objections to stratified sampling were adverse reaction from patients on learning that an applicant was admitted to professional school on the basis of lottery (Simpson 1975) and lack of acceptance by the applicants who were not selected (Chaisson 1976).

Stratified sampling offered an interesting approach to admission fairness for both the institution and student. It in effect improved the institution's accountability relative to the student selection process. From the institution's perspective a criterion variable was established which, when based on past experience of student success, reasonably assured that students could accomplish their subject work without failing. The student was given an equal chance of being selected from all applicants presenting similar credentials. It was the purpose of this study to try to understand how this form of admission procedure had been used with the 1978 graduating class at the University of Florida and what effect it had on the achievement of this class. From this experience a process model was developed to

improve future admissions using stratified sampling as part of the admission process for undergraduate physical therapy students.

Statement of the Problem

The study was concerned with a discrete group of qualified applicants all of whom would have been admitted to a professional program in undergraduate physical therapy at the University of Florida if sufficient openings had existed. However, since only a limited number of openings existed in the first-year class (i.e., admittance at the junior undergraduate level), more than half of the group under consideration were refused admission.

The purposes of this study were two-fold. The first was to examine whether a class composed of students chosen by two different admissions procedures were comparable (i.e., whether the 45 per cent selected by stratified sampling was comparable to the remainder pre-selected by higher ordinal rank). The second purpose was to develop a process model which would answer the question posed in the first purpose, and which would also improve the prediction capability, thus permitting as many qualified students as possible to be included in the pool of qualified applicants for stratified sampling.

The study identified two groups of admitted applicants:

The Pre-Selected Group (n = 14)

1a. Candidates considered superior due to high predictor variable scores, as well as a general consensus of the admission committee that they are superior applicants (n = 5).

1b. Candidates ordinally ranked, based on numerical values given to predictor variables established by experience with prior

years' applicants, and occupying the higher positions in the ordinal ranking (n = 9).

The Stratified Sample Group (n = 11)

2. A group considered qualified based on predictor variable scores, but ordinally ranked below those selected in group 1b, and selected entirely by stratified sampling from a pool of qualified applicants.

The study attempted to answer the following questions:

1. Based on the original predictor variables used for admission was there a significant difference between the two groups admitted (i.e., had they been correctly classified)?

2. Using the individual grades achieved during the first year in the physical therapy program as the independent variables, was there a significant difference between the two groups admitted (i.e., had they been properly classified)?

3. What process model would evaluate the procedures performed when stratified sampling was part of the selection process?

Need for the Study

During the past several years institutions of higher education had become, through federal legislation and subsequent court challenges, more accountable to the consumer--the student. The student had become more cognizant of his rights. To meet the potential legal challenge to the admission procedure in the physical therapy program at the University of Florida, it was decided to select part of the class of 1978 by stratified sampling, from a pool of similarly qualified applicants. The aim of this procedure was to provide equality of opportunity for a group

of applicants who presented relatively similar credentials, but for whom there were fewer places in the entering class than applicants. Refusal to the program for this group was no longer based on rank order pre-selection, as it had been in prior years, but on a stratified sample procedure. The intent of the program, therefore, was to give all qualified applicants an equal chance to be admitted to the physical therapy program.

Once the two groups were admitted, questions arose as to whether there really was a difference between the pre-selected group and the stratified sample group. How did the 1978 class compare to a prior year's class? What trends were shown by the 1978 class? Was the performance of the 1978 class during the first year significantly different from a prior year's performance? What was the effect of the stratified sample group on the composition of the entire class for 1978? If the stratified sample selection had merit, how could it be improved with time? To attempt to answer these questions this study was undertaken.

The main contribution of the study was to develop a process model for the continual evaluation of stratified sample as part of the admission procedure. The model had to be based on the experience that existed with the 1978 class, the anticipated problems that could be encountered in the future, on sound statistical analyses, and a simplicity of application which would permit its use by a maximum number of administrators wishing to use this approach in the the health professions. Such a model did not exist.

Basic Assumptions

1. It was assumed for the purpose of this study that like grades were equal, e.g., the grades of A, B, C, or D were equal regardless of subject, grading method, or instructor.

2. It was assumed for the purpose of this study that there was equal distance of one unit between grades (i.e., A equals 4, B equals 3, C equals 2, and D equals 1).

3. It was assumed that scores and grades which appeared in the student's personnel file located in the physical therapy office, the data which formed the basis of the study, were accurate and current.

Limitations of the Study

The results were limited to a single population (n equals 25) of students admitted to the physical therapy undergraduate curriculum in 1976 (graduation in 1978), University of Florida and, therefore, generalization to other populations should be applied with due consideration of the limitations of this study.

Delimitations of the Study

The study was limited to a single year due to the lack of other experience with stratified sample admissions; the 1978 graduating class was the first class admitted to the undergraduate physical therapy curriculum, University of Florida, using in part the stratified sample admission procedure.

The 1978 class actually consisted of 28 students; however, two were not used in the study since they were admitted under a special

classification of "minority" students, and a third student failed a course. Due to university regulations the third student could not proceed in the 1978 class, but could continue in the next class by retaking the failed subject.

Definition of Terms

Class of 1978--The class whose applicants were admitted as juniors in Fall 1976 and graduated in 1978.

Criterion Variable (pl. criteria variables)--The dependent variable or outcome against which one or more predictor variables are measured (e.g., in this study the first year GPA in the physical therapy program was the criterion variable). The individual grades during the first year were the criteria variables, as were the first quarter GPA, second quarter GPA, and third quarter GPA.

Dependent Variable--The effects associated with manipulation of the independent variable. See also Criterion Variable.

GPA--Grade Point Average. The average as determined by computing the ratio of grade points to credit hours attempted.

Health Professions--The technical and service occupations requiring baccalaureate or more advanced training in the medical and allied health areas, including medicine, dentistry, nursing, occupational therapy, physical therapy, medical technology, and other similar professions.

Independent Variable--The variable that was under the control of the experimenter. See also Predictor Variable.

Intellectual Factors--The variables which were measured by ability, aptitude, or achievement tests, or some measure of prior achievement

such as grade point average (e.g., 4 principal intellectual factors in this study were SCAT Total Score, Prior Overall Grade Point Average, Pre-Professional Grade Point Average, and Zoology Grade Point Average).

MCAT--The Medical College Admission Test.

Multivariate Statistics--The application of multiple regression and discriminant analysis with the data.

Non-Intellectual Factors--The variables used for predicting academic performance (first year GPA in the physical therapy curriculum) not included in the term intellectual factors (e.g., the predictor variable patient care points).

Patient Care Points--The prior experiences of an applicant in a hospital or physical therapy department. These experiences were assigned points, with a predetermined point value for each experience and length of experience (included student's observations; volunteer work; and paid employment).

Pool of Qualified Applicants--A group of applicants whose total qualifications were deemed adequate for admission to the physical therapy program, but who were not included in a predetermined number of applicants who had the highest point totals in rank ordering. The pool included applicants from the lowest acceptable point total, to the individual one position immediately below the last applicant accepted on a pre-selected basis.

Predictor Variables--The independent variables used to predict the first year achievement in the physical therapy curriculum (first year GPA). (The admission committee used 5 predictor variables--SCAT Total, pre-overall GPA, pre-professional GPA, zoology GPA, and patient care points; the study also considered in one analysis SCAT verbal and SCAT Math.)

Pre-Professional GPA--The grade point average in selected scientific courses deemed important to the clinical phase of physical therapy.

Pre-Selected Applicant--An applicant whose selection was based on a high ranking on the ordinal scale.

Random Sample, Simple--A sample drawn from a population in such a way that all possible sample of size 'n' had the same probability of being selected.

SCAT--The School and College Ability Tests. The test was designed to aid in estimating the capacity of a student to undertake the next higher level of schooling. The test was used by the physical therapy admissions committee to substitute for the defunct Florida Twelfth Grade Achievement Tests.

SCAT Math--The quantitative subtest component of the School and College Ability Tests.

SCAT Total--The combined score for the SCAT Math and SCAT Verbal subtests.

SCAT Verbal--The verbal subtest component of the School and College Ability Tests.

Stratified Sample--The dividing of the population into strata from which random samples were drawn.

CHAPTER II

REVIEW OF THE LITERATURE

The literature reviewed for the study was essentially concerned with three major categories. They included the nature of the admission procedure, the essentials of predictor variables used for selecting health professions applicants, and the study of grades as the main criterion variable considered for the study. The literature was reviewed as to its applicability to the health professions, and to physical therapy specifically.

The 1950-52 Physical Therapy Research Study

During the period 1950 to 1952, the American Physical Therapy Association commissioned a major school research program which had as its stated objectives (Gobetz 1954a):

1. To provide physical therapy schools with students of high caliber.
2. To provide hospital departments and other installations with more effective physical therapy staffs.
3. To accord the field of physical therapy a high professional status through utilization of scientific selection and placement procedures, similar to those currently in use for engineering, medicine, law and other professions. (p. 377)

As a result of the study a battery of tests was established to measure intelligence; mechanical reasoning; scientific knowledge;

knowledge of contemporary social problems; academic, recreational and vocational interests; and personality, by means of a biographical information blank. The tests were presumed to measure characteristics deemed important for success in school, in supervised clinical practice, and in clinical practice after graduation. The tests were given to all students entering physical therapy training in all schools in existence during 1950 and 1951, and to a limited group in 1952; a total of 1,128 for the entire study (Gobetz 1954a).

The study showed that interest and personality tests were not predictors of the grade point average criterion. Statistically it was found more meaningful to treat the male and female applicants' results separately. The battery of tests when used to predict grade point average in the first year had a multiple r of 0.49 and 0.48 for 1950 and 1951 for female students, and 0.37 and 0.38 for male students (Gobetz 1954b).

Among the findings presented in the research study the following were considered the most important for the purpose of this review (Gobetz 1954c):

> It is clear that academic achievement is an easier criterion to predict than is performance in a practical job situation, and this observation may well explain why so many professional aptitude tests employ academic success as a sole index of test validity. (p. 517)
>
> No mechanical system of test scores can be expected to supplant a global evaluation of the person derived from a synthesis and integration of data on previous academic history, social adjustment, interest, ambitions, emotional stability, and other relevant factors. This observation is particularly more effective in forecasting school grades than they are in predicting a clinic practice criterion. (p. 517)
>
> Other things being equal, students with very low test battery scores are poor risks for admission, and the probability of successful selection will increase progressively as successively higher scores are obtained. (p. 518)

> It cannot . . . be too strongly emphasized that all available data should be considered in evaluating the candidate's qualifications and that test scores constitute only one kind of information on which a decision to accept or reject should be predicated. (p. 519)

The Admission Procedure

Admission to a health profession program was a transition for the student from an undergraduate college program to a professional school, such as medicine, dentistry, nursing, occupational therapy, and physical therapy. Gough et al. (1963) indicated the purpose of admission procedures in the health model was to identify candidates who would:

(a) complete the training and go into professional careers;

(b) do well in and profit from the training program;

(c) perform creditably in professional practice; and

(d) possess the traits of character and ethical values to be desired of a professional person. (p. 983)

Generally the admission policy was a written or implied description of the number and kinds of applicants who would be accepted by the school. The initial decision as to the school to which an applicant would apply was made by the student, with or without guidance from others. Once the application for admission had been received the conduct of admissions was usually under the general surveillance of an admissions committee. The student was usually required to have taken an aptitude or achievement test, or both. Rarely were these tests the sole determiners of admission. The applicant was usually required to meet a minimum grade point average on prior college work and present evidence of accumulated specified prerequisite course credits in specified

subjects. The personal interview and recommendations were relied upon by many admissions committees. The greater the number of applicants to a school the more selective and formalized the admission procedures became (Dyer 1969).

Dyer (1969) reporting on Whitla's ten year study and analysis of the determinants of the decision process at Harvard College stated:

> (1) As the academic ability of the applicant pool goes up, the committee tends to put greater weight on the personal attributes of candidates;
>
> (2) the criteria the committee applies may vary from one subgroup of applicants to another, depending upon the nature of the data obtainable; and
>
> (3) the richer the data on an applicant, the more complex and unpredictable the committee's decision becomes. (p. 37)

Committee and Actuarial Methods

Two separate and distinct admission processes were identified in the literature. They included the actuarial method, and the committee or clinical method. The actuarial method selection was based on a quantitative summary of objective indices based on past and current experiences. In the committee or clinical method, a group of experts studied each case for clues to the probable career potential of the applicant; and by individual and collective judgment attempted to balance the hard evidence of academic aptitude and achievement against interest, values, personality, motivation, prior experience, and other non-intellectual factors (Schofield & Garrard 1975). Schofield and Garrard pointed out in a study by Sawyer in 1966 that:

> The overwhelming evidence from these studies is that the actuarial approach equals when it does not exceed the validity of the traditional or clinical, judgemental approach, and always has the advantages of efficiency, economy, and reliability. (p. 86)

Commenting on the advantages of the committee, they stated:

> With very large and growing numbers of applicants, the time-consuming and very expensive clinical process of committee judgements can be justified only if it can demonstrate a significant gain over what can be achieved by a more objective and efficient process. (p. 86)

Dyer (1969) summarized the pros and cons for each of the methods:

> The debate has taken a good many twists and turns since Allport delivered his famous address on the subject in 1939 (Allport, 1940). In so far as the prediction of grade-point average is concerned, the unencumbered actuarial approach has usually turned out to be a shade more accurate than the clinical approach (Sarbin, 1942; Melton, 1952; Meehl, 1954; Fricke, 1958; Gough, 1962). There is little question that if most probable grade-point average is the only basis for deciding which candidates to admit, the actuarial approach is by far the more efficient and, in view of the unknown variability of individual human judgments, more dependable. The principal counterargument is that probable grade-point average is not the only criterion for admission, and not a very satisfactory one at that, since the grade-point average reflects only a small, and possibly a relatively unimportant, part of the benefit a student derives from his educational experience and no part at all what he contributes to the college or university he attends. (p. 38)

Schofield (1970) in a study of groups admitted by actuarial and committee methods in a medical school found that there were no significant difference in students selected by one method over the other, but if one added considerations for efficiency and economy, the committee method was "clearly inferior." Funkenstein (1955) advocated the use of

the committee for its flexibility in seeing applicants as individuals, and indicated that the failure rate of 3.9 per cent at Harvard, which uses the committee method, was comparable to other schools using different admission methods.

Changing Concepts in the Admission Procedure

Changes in the admission procedure, including use of lottery or stratified sampling, were suggested in the literature. Funkenstein (1970) indicated:

> Marked pressures for change in admission policies are building from groups both in and outside of medical schools. There is a clear danger that orderly modifications, based on a reasoned analysis of the problems, may not take place, but rather that they will be dictated by whichever group--students, faculty members, or society--can gain the most influence. (p. 497)

Mattson (1969) advocated the use of decision theory in admission, an outgrowth from the field of economics, and also uses in industrial quality control in accepting or rejecting products. Mattson indicated that the elements of decision theory which include tests, treatments, outcomes, costs, values of outcome, probability of outcome, and utility of outcome were all compatible with existing information available to the admissions committee. Bogue (1968) addressed decision theory to the cut-off point in student selection. The admission committee established a value as to what they considered successful or unsuccessful, and applied it to the criterion variable in such a manner that they lost a minimum of students in the admission process. This could be flexible from group to group, and varied with the predictor and criteria variables used.

Jason (1972) recommended systematic recruitment to ensure the qualities one desired from an applicant. Cole (1973) attacked the admission problem from the standpoint of bias in the admission process. She suggested that fairness or equal opportunity for the potential applicant must be considered in the admission model. Six models of admission were considered including the quota model, the regression model, the subjective regression model, the equal risk model, the constant ratio model, and the conditional probability model. The author advocated the conditional probability model and stated that it was "an intuitively appealing and socially desirable model for use in many selection situations" (p. 237). Rosenberg (1973) placed emphasis on improving the efficiency of the admission procedure. He suggested greater efficiency could be realized in the admission process through the publicizing of admissions data, the use of a single page summary sheet on each applicant for comparison purposes, the selective use of interviews, ranking of the most acceptable applicants only, and the use of feedback information on progress and careers of accepted applicants for use of admission officers. In professions such as medicine, where large numbers of applicants tend to apply to as many schools as their finances will permit, admissions matching was advocated by Marcus and Riggs (1974). A central agency would coordinate the matching of acceptable applicants to openings for a number of schools.

Morgan (1974) suggested more emphasis should be placed on selecting students into a program, rather than screening students out. She questioned using the predictor variables of prior grade point average and aptitude tests, and indicated more emphasis should be placed on learning style, personality qualifications, motivation, and creativity.

In the professional school the criterion variable should be clinical performance rather than grade point average.

Admission criteria in higher education in general ran the gamut of selecting only the best, to open admissions where anyone wishing to apply for an education was admitted. Black (1972) explored the changing philosophies of admission in higher education from the perspective of the open door policies. He concluded that while open admissions should be considered from the economic and social aspects, this policy was questionable from a practical point of view, and that prime admittance should be given to ". . . those who are best equipped to do a certain educational job . . ." (p. 48). Bard (1975) evaluated the open door policy of the CUNY, the City University of New York. He concluded the success for open admissions appeared to be remedial courses for those admitted, and more liason to provide basics in the schools from which the students came prior to entering the university.

De Witt (1971), in discussing selective admission and equal opportunity of admission to the applicant's school of choice, stated:

> Certain individuals should not be favored over other individuals. . . . Furthermore, it would do much to reduce such enormous domestic crises as poverty and the distribution of income, and frictions between races and income classes were we to establish a more fully equal system of higher education in which everyone regardless of race, creed, sex, academic achievement, or native intelligence, is given an equal chance to reap the benefits of higher education. A lottery system for selection into higher education and into particular institutions of higher education appears to be one way to accomplish that social objective. (p. 4)

While the literature suggested the use of stratified sampling, lottery, or lot in the selection process, it was usually expressed with

reluctance. There was no report of its actual application, and where it was mentioned there was usually a caution that it would be difficult for many to accept. Kurland (1968) advocated stratified sampling on the basis that its ". . . adoption would bring into the open what probably already happens in many situations," and that for public institutions it is more democratic (p. 222). He further observed that the element of chance would be repugnant to the retractors of this form of admission procedure.

Funkenstein (1970) recommended "lottery" for a certain number of the newly admitted as the only fair way of dealing with large numbers of equally qualified individuals seeking too few openings. He recognized that this could be a distasteful way to many. Simpson (1975), similar to Funkenstein, suggested that "random or lottery selection" substituted "overt randomization for covert randomization" (p. 417). He also favored lottery for its elimination of prejudice and bias, and with doing away with the guessing involved in selection procedures. The main objection to this method, he reported, was the concern of a patient going to a doctor s/he felt became a physician because his name was drawn out of a hat.

Chaisson (1976) saw the use of lottery for the statistical value of reducing selection errors, and like Funkenstein saw it used for selecting a segment of an entering class. She further noted that she did not believe that the students would be anymore satisfied with a system of chance than they were with a system of choice.

Use of the Computer in Admissions

From the years 1939-40, to 1976-77, first year students selected to medical school have increased 266 per cent, from 5,794 to 15,397; and applications have increased 359 per cent, from 11,800 to 42,340. The number of 22 year olds who form the basis for most applications to medical school, and other health professions, will increase until 1985, and thereafter will start to decrease. However, the increased number of female and minority applications makes this decrease of potential applications uncertain (Lambson 1975).

Ambrosino and Brading (1973) reported for the year 1973 close to 4,000 applications for 110 places in the first year medical school class at Albany Medical College. Using stepwise multiple regression the computer was used to determine who should be interviewed, who should clearly be rejected, and those who should be considered closer before an interview should be arranged. The study they conducted indicated that the computer's use was useful in processing a large number of applications. Hill and Siegel (1966) reported the use of electronic data-processing at the Downstate Medical College of Medicine, Brooklyn, to compile applications information; with the stated objective of making the work of the admissions committee more efficient, not to supplant them. The aim of the computer system was

(a) grouping appliants according to their objective records (grade-point averages and MCAT scores),

(b) helping to manage the selection procedure,

(c) rapidly assessing the state of the application pool,

(d) providing data for admissions research, and

(e) keeping the applicant informed of his status. (p. 947)

Thompson (1968) reported on a survey conducted in August 1967 by the Association of Medical Colleges of the then current and projected uses of electronic processing equipment in 113 American and Canadian medical schools; 45 used the computer for admissions. The computer was used for dealing with preadmission records, for processing applications, to obtain data for screening prior to arranging an interview, data for the interview, data summaries for the decision process, and for research in the admission process.

The University of Illinois College of Medicine's admission committee used the computer to develop prediction formula and weighting of the predictors available (Best et al. 1971). Immediately prior to the decision process by committee members new predictor readouts on the computer were made for each applicant. This allowed for better communication and comparison of potential applicants for acceptance purposes. Kimball (1972) advocated the use of the computer to better objectify the work of the selection committee, to make the process more efficient, and make contacts with applicant less perfunctory and more meaningful.

The Q-Sort Technique

Trotter and Fordyce (1975) reported on an alternate technique for admissions to a physical therapy program--the Q-Technique--used at the University of Washington, Seattle.

> This process has the characteristic of permitting each of several judges to make judgments using whatever criteria and assigned weights they choose. It also permits precise and relatively simple comparison of the degree of agreement among the judges and the relative contributions of different elements of data upon which judgments are made. (p. 151)

There was a recognition of variability of applicants in personality, ability, and interest, characteristics most often sought in the clinical phase of physical therapy practice. One-hundred and sixty-five applicants were evaluated by selection, categories were established, and using forced choice each candidate was rated from 1 to 10, with limits of total numbers in each rating. Six class intervals or categories were established, and then summed for each applicant. The highest score for an applicant was 60, the lowest 6. They then were ordinally ranked with the top 32 selected. No statistical follow-up was reported for this study.

Predictor Variables

Cognitive Factors

The admission committee is required to select a limited number of students from often times a large and, for the most part, qualified population of applicants. The committee can readily reach agreement on what constitutes an outstanding record and what constitutes an inferior one, but they have a great difficulty in dealing fairly with those applicants whose qualifications fall between these extremes. By what measurable criteria can one judge the competency of an applicant to a health professions school?

Experience has demonstrated that certain predictor variables are indicators of success in the first year of professional school. By the use of multiple regression each school may determine the predictor variables which best meet their success criteria, and from these arrive

at a prediction formula. Best et al. (1971) developed the following criteria for the selection of the final prediction formula:

1. It should include only variables which are realistically useful in prediction.

2. It should use a large enough number of variables to approach realistic limits of predictability.

3. It should not include variables which might be construed as discriminatory, for example sex or race.

4. It should include a sufficient variety of predictor variables so that an individual with imbalanced credentials would not be unduly aided or handicapped through the chance relationship of his particular imbalance with the variables included in an equation.

5. It should insure that coefficients are of such a sign as to reward applicants for superior performance. (p. 44)

From the study conducted by Best et al., a maximum of three to five variables were best in the prediction formula. Grade point average and MCAT scores were found to be among the more useful predictors. Consideration for type of college prior to medical school was also considered as a useful predictor.

Ambrosino and Brading (1973), using a random sample of 176 at Albany Medical College in a stepwise multiple regression procedure, determined that nine predictor variables were useful in determining first and second year success in medical school. The intellectual variables included MCAT Verbal Ability subtest score; the MCAT Science subtest score; the overall undergraduate grade-point average; a grade-point average of selected courses required for admission; and an internal mechanism for ranking undergraduate colleges, based on the overall MCAT score average for each school. Among the non-cognitive factors considered were age of applicant at time of application; the father's

occupation--based on a 7 point scale; and undergraduate extracurricular activities, based on a 12-point scale.

Houston and Mensch (1975) using normative data for 370 students at the UCLA School of Dentistry determined pre-professional GPA, Dental Aptitude Test academic average, attendance at a California State University System school, and high school standing were desirable predictor variables. This study found that predictors were correlated more to earlier years in school than later clinical achievement.

Gough et al. (1963) indicated that each school should determine the merit of predictor variables for their own applicant population. In attempting to determine why predictor variables usually fared badly as forecasters, Gough et al. advanced the arguments that the range of scores among the students selected were significantly reduced, or that selectees with high predictive value scores lost their sensitivity in the upper portions. However, they went on to refute these as the probable causes for this phenomenon. Other hypotheses advanced were that undergraduate achievement tests tended to have their highest validity at the undergraduate level and did not fully account for independence, self-initiation, and critical judgment required of the professional; or that not enough emphasis was placed on divergent or creative thinking; or that the range of forecasters was too narrow.

Gottheil and Michael (1957) in discussing predictor variables indicated that premedical grades were the best predictors of medical school grades, and when combined with aptitude tests formed even better predictors. Roemer (1965) conducted a study using the four parts of the MCAT, the average score on the MCAT, and the overall grade point average in undergraduate courses, and used the four years of grades in medical

school as the criteria variables. He concluded that the best predictions were made for first year grades, and that as the student progressed in medical school the predictors became less effective and were least effective in the fourth year; of all the predictors studied premedical grade-point average was the most important. In a study conducted by Davis et al. (1976) at the University of Kentucky College of Medicine, on 586 students admitted between 1961 and 1968, the science grade point average and the MCAT Science subtest component showed a significant difference from other variables used, leading to the conclusion that basic skills in science were generally regarded as necessary for academic success in medical school. A study by Crowder (1958) at the Medical College of Georgia with 187 freshmen yielded a similar finding.

Addressing themselves to predictive validity in using aptitude tests Sanazaro and Hutchins (1963) concluded:

> The purpose of admission procedures can be interpreted as an attempt to reduce the predictive validity of the instruments being used by admitting only those applicants who will perform well academically. (p. 1046)

They found when test scores were used properly in the selection of students aptitude tests progressively lost their utility for predictive purposes. Use of multiple predictors increased the range of scores for admitted students, but reduced the validity over time. They indicated that the MCAT was not designed to predict professional competence, but to determine the intellectual capacity of applicants to complete successfully the medical curriculum.

Erdmann et al. (1971) suggested that the MCAT Verbal and Quantitative subtests could be substituted by similar aptitude tests such as the

Miller Analogies Test, the Graduate Record Examination, the American College Testing Program, or the Scholastic Aptitude Test of the College Entrance Examination Board.

Baird (1975) in a comparative study of predictors of academic performance in post-graduate fields, three liberal arts and three professional--including medicine--found that academic aptitude and achievement were important in every instance. Grades were more important as predictors than were admission test scores in every field except law. Tests were most accurate in law and business, least accurate in medicine.

Rock et al. (1970) stated that reducing the number of predictors was important for cost and examinee time. Under certain conditions a system with few predictors could often produce equally accurate and sometimes better prediction than a more extended system.

In a study at the University of Oklahoma School of Nursing, the Iowa High School Content Examination contributed an r square of 0.31 when accounting for grade variance in nursing school (Dorffeld et al. 1958). Munday and Hoyt (1965) used American College Tests to validate the ACT tests for predicting grades of nursing students in seven schools of nursing, with N of 100, to N of 865. Using standard ACT data, the ACT was an excellent predictor of over-all grades in the first year of nursing school. Michael et al. (1965, 1966) found the California Reading Test and the California Mathematics Test to be the most promising predictors of success in the academic program in nursing. Burgess and Duffey (1969) concluded that prenursing GPA was the single most significant predictor of nursing school GPA. Weber et al. (1973) investigating predictor variables used in 25 schools of practical nursing in Virginia, N of 922 students, found that the Pre-Admission Classification

Examination (PACE) scores were a more valid examination for selecting practical nurse students than the General Aptitude Test Battery, and suggested that the latter be discarded in favor of PACE.

Non-Cognitive Factors

Owen and Feldhusen (1970) reported on the work of Lavin (1965) in reviewing the multiple correlation technique in academic prediction of college achievement. Lavin found that academic predictor variables accounted for 30 to 45 per cent of criterion variance. Owen and Feldhusen went on to point out that:

> While some researchers have relegated the untapped criterion variance to "error variance," others are more optimistic about identifying its components. Lavin, for instance, suggested that the usefulness of most cognitive predictors may have peaked and that we may profitably embark on a search for nonacademic predictors of school achievement to build upon that "cognitive peak." Lavin proposed that such variables as creativity, motivation, biographical data, and personality traits be investigated for their contributions to the prediction of academic success. (p. 518)

Interest

Sanazaro and Hutchins (1963) reported that the Association of American Medical Colleges was interested in a longitudinal study of non-intellectual characteristics of entering classes into medical school, to determine achievement in school and later performance; of particular concern were attitudes, interests and personalities. Gottheil and Michael (1957) reporting on the Strong Vocational Interest Blank, physician scale, indicated that individuals could voluntarily increase their scores thus decreasing its value for selection. However, a

follow-up study found that the higher the physician interest score while in college, the better the chance of becoming a physician. Dunteman (1967) reported that in using the Strong Vocational Interest Blank for Women he could effectively discriminate between occupational therapy, laboratory technology, and nursing students, as well as non-professional students.

Wellock (1975) reported on the Opinion Attitude and Interest Survey (OAIS) scores obtained by freshmen in various schools at the University of Michigan, and the scores of freshmen physical therapy students from the years 1968 to 1972. The physical therapy students exhibited different opinions, attitudes, and interest from 18 other freshmen groups. Wellock stated:

> They indicated that they were more conventional and that they could function about equally well independently as in interpersonal relation situations. They exhibited a higher degree of self-confidence, maturity, and sense of well-being, and a higher interest in living things and life processes. They showed greater interest than did fifteen of the other groups in financial matters, material worth, power, and practical concerns; and greater interest in people, human interactions, and problems than did fourteen of the other groups. (p. 375)

Further research was necessary to establish the relationship of OAIS between practicing therapists and students for the instrument to be used for selection purposes. The results of the study were similar to that of Goldschmid (1967) who found that students in a particular major share certain personality traits which are significantly different from those in other majors.

Schofield and Merwin (1966) investigating the admission of students to the University of Minnesota Medical School found that premedical

achievement contributed relatively more to prediction for students with questionable MMPI personality scores and Strong Vocational Interest Blank interest scores, than did applicants who were deemed favorable in these respects.

Personality

Chansky (1965) studied the Structured Objective Rorschach Test and its effect on college freshmen GPA in six different curricula at North Carolina State, Raleigh. No findings of significance were determined. Gottheil and Michael (1957) reported that 7 of 8 failing medical students showed definite disturbances on the Rorschach test. They also reported on the findings of Shoemaker and Rohrer (1948) who found a different pattern in Rorschach results for over- and under-achievers as measured by the results of the Professional Aptitude Test, and the grade points earned in the first year of medical school. Eron (1954) used 35 male medical students and a control group of 35 divinity students to test the Rorschach test for predictive purposes in medical student selection. He concluded that there was insufficient evidence for using it as a selection device in medical schools, other than on an experimental basis.

Gough (1953) developed a 32 item personality test based on the California Psychological Inventory. He developed what he called an Hr scale (honor point ratio) which had a mean correlation of 0.38 with academic achievement. In a sample of 40 senior medical students it revealed a significant correlation with ratings of success in medical training, as well as breadth of interests, originality, flexibility, and vitality.

Chaison (1976) pointed out that the Association of American Medical Colleges in a survey conducted in medical schools in 1972 found that very few schools used personality tests. Where they were used they were used primarily for counseling rather than selection.

Himelstein (1965), using subjects drawn from sections of introductory psychology at New Mexico State University, found that seven subscales of the MMPI significantly correlated with the American College Test and have validity as predictors of success in school. Frick (1955) used an experimental sample of 267 freshmen women at the University of California, using the MMPI and the American Council On Education Psychological Examination and correlated them with GPA. One of the main conclusions drawn by Frick was

> Additional correlations with ACE as the dependent variable and MMPI scales as independent variables suggest that personality factors affect performance in the form of ability scores obtained at any given time as well as performance over a long period of time in the form of grades. (p. 52)

The interview

> Most medical schools either suggest or require an interview as part of their selection procedure. In such an interview an attempt is made to appraise the individual as a whole over and above the grades, test results, and other available background information. The interview is concerned with the individual's appearance, carriage, personality, interests and motivation, or those areas which are most difficult to test objectively. (Gottheil and Michael 1957, p. 139)

Gough et al. (1963) commented on studies of Richards and Taylor, and Kelly. Richards and Taylor (1961) found a correlation coefficient of 0.03 for the interview ratings of the premedical advisory committee,

and Kelly a coefficient of 0.05. Kelly (1957) further concluded that the admissions interview was invalid as a predictive instrument.

Gough (1967) indicated that the evidence he reviewed indicated a very low and possibly lacking degree of predictive validity for interviewers' ratings. A World Health Organization work group (WHO 1973) questioned the use of the admissions interview in the selection procedure.

Taylor (1948) commenting on the work of Harry A. Murray in his book, The Assessment of Man, quoted the author:

> A personal interview was the most important test of our thirty-odd testing procedures, but there are no definite figures which confirm this impression. The value of the interview depends on the interviewer's talents and experience. Even the best interviewers, however, make numerous predictive errors. Multiple interviews are the most reliable guide in the selection of personnel. (p. 171)

Taylor further stressed the interview should not be used for objective measuring but for evaluation of personality factors. Stubbs et al. (1951) saw the interview as more than an evaluation procedure in the admission process. They saw it as establishing a relationship with the student; as a public relations function; for the education of the faculty interviewers; and for vocational guidance of rejected applicants. They stressed that the interview should have clearly defined objectives, that the interview limitations should be recognized, that it was only part of the medical selection process, that it varied from institution to institution, and the interviewers should be striving for growth and increased skill through a continuous self-examination.

Wood et al. (1949) advocated the use of group interviewing over individual interviews. Gelman and Steward (1975) explored the use of

student interviewers at the Stanford University Medical School. It was felt that more new material was given to student interviewers than faculty interviewers, and that applicants tended to discuss non-academic concerns better with student interviewers. Kopelman (1975) evaluated the order in which applicants were evaluated. It was found the applicant's performance was the most significant determination of the rating he received, but with applicants of intermediate performance comparison with prior applicants could affect the rating.

Biographical inventory

Pinkston and Margolis (1970) in reviewing the use of the Biographical Information Blank, or as others may refer Biographical Inventory, stated:

> The B.I.B. is a measuring instrument consisting of multiple choice items concerned with childhood activities, academic activities, attitudes, values, interests, and any other self-descriptive categories that seem appropriate for the subject area for which the instrument is being used [Siegel 1956]. It can be used to obtain an objective quantitative estimate of the applicant's potential in a particular field of endeavor [Taylor and Ellison 1967; Anastasia et al. 1960; Asher and Gray 1940]. When used with other selection devices the B.I.B. has potential to increase the predictability of success on the job. (p. 1713)

Myers (1952) conducted a study in 1951 with 355 freshmen female students to determine whether biographical factors significantly added to the prediction of freshmen year GPA. Among the predictor variables used were SAT Verbal, SAT Math, and high school GPA. Seven biographical items, which were statistically significant at the 0.01 level, raised the multiple r from 0.62 to 0.65. They were religion, extent of participation in organized activities outside of school, size of home town,

county of residence, nativity of parents, birth order, and number of school offices held.

Siegel (1956) pointed out that biographical information blanks based upon specific job analyses could be constructed with validity. He stressed their use for counseling and clinical areas.

Taylor and Ellison (1967) described in detail their Biographical Inventory with 2000 scientists, and the relation to success in science. They wrote:

> The BI contains a wide variety of questions about childhood activities, experiences, sources of derived satisfactions and dissatisfactions, descriptions of the subject's parents, academic experiences, attitudes and interests, value preferences and self-descriptions and evaluations. The items thus encompass a wide variety of information are not limited to a narrow definition of what could be included within the rubric of biographical information. By using such a broad approach, one potentially can attempt to measure not only previous life history experiences and past environmental effects on a person, but also to assess the outcome or manifestation of the hereditary environment combination as it is personified in the individual studies. (p. 1075)

Mackenzie (1967) reported on the use of the Holland and Nichols Extra-Curricular Achievement Record, a biographical inventory of extracurricular accomplishment, with 104 first year dental students at the University of Pittsburgh School of Dentistry. They supported the predictive validity of the inventory, and Mackenzie stated they determined that:

> Students who participated in leadership, scientific, or general extracurricular activities as undergraduates continued to participate in similar activities while in dental school. (p. 546)

They reasoned that most professions were interested in qualities of leadership and scientific and cultural interests. Since biographical inventories could elicit this information, it was valuable in selecting candidates for professional school.

Aiken (1964) constructed a 76-item multiple-choice biographical inventory and administered the inventory to 1,006 freshmen college women. He then randomly selected two groups of 100 each. Using the predictor variables of SAT Verbal, SAT Math, and in high school class, and Biographical Inventory he regressed them against the freshman year GPA. Biographical Inventory information had the highest correlation with GPA, and contributed significantly to predicting the criterion.

Haley et al. (1971) in evaluating the relationship between 21 items of a biographical inventory of freshmen medical students found a significant difference among high, middle, and low MCAT factor groups. Those significantly different biographical data included age of decision to enter medical school, age entered medical school, source of medical information, undergraduate major, primary interest in medical school, career desired, and specialty interest.

A study by Payne et al. (1973) with 1,951 freshmen students at a Southern university, attempted to demonstrate the effectiveness of a factored biographical inventory in predicting freshman GPA. The study indicated that the best predictor of future performance was past performance. The findings for males showed that in addition to high school GPA, SAT Verbal and Math scores, and past academic achievement--social introversion and parental control were important biographical data; for women popularity with the opposite sex was important. Parental control was the only significant biographical data for predictive purposes.

They concluded that biographical data in college selection should be given serious consideration.

Blume (1976) described the development of a Biographical Data Inventory (BDI) to identify behavioral correlates of successful medical technologists, and a standard form to evaluate students at the end of their clinical experience. Results of the study showed a 0.68 correlation between BDI scores and evaluation scores. Items dealing with degrees of flexibility, sociability, and interest in problem solving showed the widest difference of responses between upper and lower groups. The author expressed the belief that the inventory reported in the study could be used with other allied health professions.

Other factors

Corlett (1974) investigated the relationship of library skills, study habits and attitudes, and sex to the academic achievement of college freshmen. Library skills, as measured by the Library Orientation Test, appeared to be valid for forecasting success in college as measured by GPA at the end of the first semester. It accounted for 16 per cent of the total accounted variance of 25 per cent. Study skills as measured by the Brown-Holtzman Test accounted for 6 per cent of the variance, and the sex category 3 per cent. Women tended to achieve higher than men.

Fredericks and Mundy (1967) conducted a study using 82 freshmen medical students at a midwestern school to explore the interrelationship of social class, average grade in college, MCAT scores, and academic achievement in the first year of medical school. The study revealed no relationships between social class and the other factors considered.

It, therefore, appeared that the admission committee should not select a medical applicant on the basis of social class.

Owen et al. (1970) conducted a study with 174 freshmen nursing students, using as the predictor variables high school GPA, two tests of short term memory, the SAT Verbal and Math scores, prior education in years, percentile rank in high school, the Nurse Attitudes Inventory, Nursing Sentence Completions, Guilford's Consequences, Alternate Uses, and a creativity self-rating scale. The achievement criteria were the student's GPA over four semesters, individually and cumulatively. The question asked in the study was, "Do two attitude measures, designed specifically for prediction of achievement in nursing education, and a set of divergent thinking tests increase the predictive efficiency of an established set of cognitive predictors?" (p. 867). Thinking tests added a unique and significant increment to the prediction of grade averages in nursing education.

Grades as Criteria Variables

The question to be determined in any admissions study is the criterion, or multiple criteria, to be used to judge the predictor variables. While many researchers and educators decry the use of the imperfect grade point average as a criterion variable, and would prefer to use clinical performance in the case of the health professions, the relationship between predictor variables and criteria variables appear to have an inverse relationship to time; the further away one gets from the measurement of the predictor variables, the poorer is the correlation. Inevitably most researchers in admission studies tend to use GPA as the criterion variable for reasons reviewed in this section.

Bogue (1968) observed relative to admission procedures:

> A grade point average is frequently used as a criterion because as Barclay points out, "It is easily obtained, pin-points success in terms of a concrete criterion, and provides an immediate recognition of those values in which college and university communities tend to place most confidence [Barclay 1965]. (p. 134)

Dyer (1969) stated:

> Multiple correlations with freshman grade-point averages usually run from about .50 to slightly above .60, depending on the type of institution and the homogeneity of the student body, and these correlations seem to represent the upper limits of accuracy with which presently available criterion measures of academic performance can be predicted. (p. 38)

Chansky (1964) noted that the "GPA bases its existence upon capricious judgments and volatile criteria" (p. 96). In citing Rugg (1915), who studied several thousand grades, it was observed that the distribution of teachers' grades were skewed. Even where symmetrical distributions were used by the teachers they did not usually correspond to the normal probability curve of 2.5-13.5-68.0-13.5-2.5. Since teachers tended to raise the knowledge and competency of their students, a negatively skewed curve of achievement was to be expected. To some teachers grades were names of categories (nominal), and to others they ordered achievement (ordinal). This accounted for some of the error seen when grades were used as the criterion variable. Ordinal grading was to be preferred. Problems could arise in ordinal grading when students on different tracks (e.g., high or low track) were given grades. An "A" in a higher track might not be equivalent to an "A" in a lower track. More objectivity in marking would also improve reliability. Chansky concluded that

when using grades with the ordinal scale, the median grade was preferred and that non-parametric techniques should be used in studies involving grades.

Haley (1973) observed that studies of correlation of the MCAT with GPA assumed that grades were unidimensional--those who did well in one course did equally well in all other courses. He suggested it may be more desirable to factor analyze or consider grades in their pure components, if the true relationships were to be understood.

Hill and Heck (1960) recommended that GPA should be analyzed relative to the college and its standards of grading, rather than assuming that all "As," "Bs," "Cs," and "Ds" were equal. They studied 1,040 students who were admitted over the period 1950-56. Sixty-three per cent of the students came from ten colleges, the remaining 37 per cent from 72 colleges. Using scattergrams and correlations with the experience of the grades at the medical school, grade adjustments were made for each school to standardize the grades.

Etaugh et al. (1972) attributed the low reliability of GPA to the diversity in grading practices, rather than on direct computation. The authors undertook a study consisting of 4,288 undergraduate students and 215 graduate students who had completed two or more courses during the spring semester of 1970-71 at Bradley University, to determine the reliability of single grades, and grade averages. They found that the mean GPA rose steadily for the freshman to the graduate level, while the standard deviation and the average number of courses decreased. All GPA reliabilities decreased from freshman to graduate years. Single-grade reliabilities remained constant over the freshman to graduate years.

The decrease in GPA reliabilities was mainly the result of the decrease in the average number of courses taken at the upper levels. Etaugh et al. stated:

> The present findings show that the reliability of the GPA depends on three factors: the number of course grades, the average reliability of these grades, and the credit-hour weights. Adequate reliability for the GPA can almost always be assured by the simple expedient of including a sufficient number of courses. (p. 1048)
>
> The present findings suggest that unweighted GPAs will yield somewhat higher validity coefficients than weighted GPAs. (p. 1048)
>
> There is probably little reason to expect that the search for new predictors of the overall performance represented by the GPA will be very fruitful. (p. 1049)

CHAPTER III

RESEARCH DESIGN AND PROCEDURES

This was an ex post facto research study in which several continuous independent variables obtained from student records at the University of Florida, Physical Therapy Curriculum, were investigated.

The independent variables were analyzed to determine their relative value in predicting academic performance represented by the grade point average, the dependent variable. The data analysis also provided a weighted combination of the independent variables which maximally differentiated those students in the 1978 graduating class who were in a stratified sample group, from those who were in a pre-selected ordinally ranked group.

The purpose of the design was to develop a process model which could be useful in the future analysis of data of a similar type, and under similar conditions. Such a process model would also be useful in evaluating new predictor variables, i.e., independent variables, if they were added to, or replaced independent variables considered in the study.

Subjects

The potential subjects for the study were twenty-eight students who were admitted to the first year class Physical Therapy Curriculum (the junior year, University of Florida, Gainesville) in the Fall of 1976, for graduation in 1978. Two of the subjects were admitted under a

minority classification and were not included in the study; and one subject was dropped from the study due to failure in a single course which had to be repeated the following year, thus preventing the subject from continuing beyond the first quarter of the first year. There were, therefore, 25 subjects in the study.

A second group of 32 subjects, used for comparison and cross-validation, were used in the study. These subjects were admitted to the first year class Physical Therapy Curriculum in the Fall of 1975, for graduation in 1977.

Method of Data Collection

The data for the study were obtained from existing student records maintained by the office of the Physical Therapy Curriculum. The individual student files contained all the data necessary for the study, and were examined and recorded by the researcher only. The data included the first five independent variables shown below, which were the basis for the admission procedure used by the admission committee plus two independent variables used in one of the analyses in the study. Also included were first year grades in the Physical Therapy Curriculum for the 1977 and 1978 subjects.

The data included in this study were as follows:

Independent Variables

1. SCAT total score.
2. Grade point average, overall prior to admission, college level.
3. Grade point average, preprofessional courses prior to admission, college level.
4. Grade point average, zoology courses prior to admission, college level.

5. Total patient care points.
6. SCAT verbal score.
7. SCAT math score

Dependent Variables

1. First quarter GPA, physical therapy.
2. Second quarter GPA, physical therapy.
3. Third quarter GPA, physical therapy.
4. First year GPA, physical therapy.
5. Course grade, HRP 331, Basic Anatomy and Physiology.
6. Course grade, HRP 332, Lab, Anatomy and Physiology.
7. Course grade, HRP 417, Kinesiology.
8. Course grade, HRP 431, The Nervous System.
9. Course grade, HRP 433, Medical and Surgical Disorders.
10. Course grade, PHT 301, Introduction to P.T.
11. Course grade, PHT 311, Clinical Science 1.
12. Course grade, PHT 312, Clinical Science 2.
13. Course grade, PHT 332, Human Anatomy.
14. Course grade, PHT 351, Physical Modalities.
15. Course grade, HRP 496, Individual Studies.

Data Analysis

The statistical treatments used, which utilized a computer program within the Statistical Package for the Social Sciences (Nie et al. 1975), were

1. Subprogram T-TEST, comparison of means, independent samples.
2. Subprogram DISCRIMINANT, with stepwise option, discriminant function analysis.

3. Subprogram REGRESSION, with forward stepwise option, multiple regression analysis.

These were established, economical, univariate, and multivariate procedures available through the Center for Instructional and Research Activities, Northeast Regional Data Center, University of Florida.

The computer card data coding of examples of each deck setup were shown in Appendices A and B.

CHAPTER IV

RESULTS, ANALYSIS OF DATA, AND THE PROCESS MODEL

Introduction

This chapter was organized around the analysis of data in order to develop a process model. The results of the data were presented in four major sections, as follows:

1. Comparison of group means on five predictor variables and one criterion variable, between the 1977 pre-test group and the 1978 test group. The purpose of these data was to compare the two groups to determine if they were comparable. The t test was used to analyze the variables involved.

2. Analyses to distinguish between the pre-selected group and the stratified sample group, in the 1978 test group. Two subsets of discriminating variables were used to analyze the data. Subset one included the five predictor variables used to select the applicants, plus the SCAT verbal and SCAT math. Subset two included the eleven course grades achieved by the applicants during the first year in the physical therapy curriculum. A separate analysis was performed for each subset. A multiple discriminant analysis in a stepwise manner was used in both analyses.

3. The assignment of weights to five predictor variables based on their contribution to the variance of the criterion variable of first year grade point average, with the purpose of developing a prediction

formula. A stepwise multiple regression was used on the combined data for the 1977-1978 groups. A cross validation analysis was performed to validate the formula developed with the predictor variables, using the 1977 year.

4. The comparison of group means of three criteria variables, between the 1978 pre-selected group, and the stratified sample group to determine group differences as a post-hoc procedure for trend analysis. The t test was used to analyze the variables involved, the first, second, and third quarter grade point averages.

A fifth section presented and discussed the process model.

1. t Test-- Comparison of the 1977 and 1978 Groups, Five Predictor Variables and One Criterion Variable

This statistical treatment was a t test of significance which utilized the SPSS computer program. It was a test between groups. The first group consisted of 32 subjects who were chosen by pre-selection for the 1977 graduating class; the second group, the test group, consisted of 25 subjects who were chosen partly by pre-selection (n = 14), and partially by stratified sampling (n = 11) for the 1978 graduating class.

The values for the t test analysis with pooled variance estimates for the 1977 and 1978 groups on the six variables of SCAT total, pre-overall grade point average, pre-professional grade point average, zoology grade point average, patient care points, and first year grade point average, physical therapy are presented in Table 1. The table includes the means, standard deviations, and the number of subjects in the 1977 and the 1978 groups used in the analysis between each variable.

Table 1

t TEST VALUES ON GROUP DIFFERENCES OF SCAT TOTAL, PRE-OVERALL GPA, PRE-PROFESSIONAL GPA, ZOOLOGY GPA, PATIENT CARE POINTS, AND FIRST YEAR GPA, P.T. FOR 1977 AND 1978 CLASSES

Predictor Variable	n	Mean	Standard Deviation	df	t
SCAT Total					
1977 Group	32	64.2813	27.445	55	0.89
1978 Group	25	70.2800	22.073		
Pre-Overall GPA					
1977 Group	32	3.3047	0.373	55	0.34
1978 Group	25	3.3408	0.423		
Pre-Professional GPA					
1977 Group	32	3.2122	0.475	55	1.38
1978 Group	25	3.3812	0.437		
Zoology GPA					
1977 Group	32	3.1728	0.847	55	0.79
1978 Group	25	3.3416	0.739		
Patient Care Points					
1977 Group	32	20.7188	9.333	55	0.68
1978 Group	25	22.3200	8.204		
Criterion Variable	**n**	**Mean**	**Standard Deviation**	**df**	**t**
First Year GPA, P.T.					
1977 Group	32	3.3328	0.393	55	1.31
1978 Group	25	3.4664	0.364		

($p \leq 0.01$)

No significant differences were found for any of the five predictor variables analyzed, nor the criterion variable of first year grade point average. It would appear from this analysis that the two groups are comparable.

2. Stepwise Discriminant Analysis-- Group Affiliations for 1978 Test Group: Pre-Selected and Stratified Sample

This statistical treatment was a stepwise discriminant analysis which utilized the SPSS computer subprogram DISCRIMINANT. Separate analysis was performed for predictor variables and for first year courses. Both samples consisted of 14 subjects who were admitted to the physical therapy program on the basis of rank order pre-selection criteria, and 11 subjects who were admitted on the basis of stratified sampling, a total of 25 subjects who together formed the 1978 class.

The computer program performed a multiple discriminant analysis in a stepwise manner. At each step one variable was selected from the variables not in the analysis and entered into the set of discriminating variables. The variable selected at each step was the variable which provided the greatest improvement in classification between the pre-selected students and the students chosen by stratified sampling. The sequential selection of the next best discriminator at each step produced the best set of variables for discriminating among the two groups, and produced a reduced set of variables possibly better than the full set, but at the least almost as good (Nie et al. 1975).

The analysis of the data developed a prediction equation for each of the two groups. The equation consisted of one for predicting

pre-selection group affiliation, and one for stratified sampling group affiliation.

The method selected for this analysis was the Wilk's lambda. The criterion was the overall multivariate F ratio for the test of differences among the group centroids. The variable which maximized the F ratio also minimized Wilk's lambda, a measure of group discrimination. Group assignment was based on the distance from the centroid, with the actual group assignment determined by the closest distance to one of the centroids.

Predictor Variable Analysis

The prediction equations developed by the stepwise discriminant analysis was a constant term and a lambda coefficient for each of the predictor variables.

The equations developed for the predictor variable analysis were as follows:

PS = -81.18419 -0.21568(V1) +0.33113(V3) +38.61003(V4) +0.44348(V7)

SS = -55.61697 -0.163(V1) +0.24623(V3) +32.33356(V4) +0.35808(V7)

where:

PS = Pre-selected group of 1978 class

SS = Stratified sample group of 1978 class

V1 = SCAT verbal

V3 = SCAT total

V4 = Pre-overall GPA

V7 = Patient care points

The predictor variables were entered into the discriminant analysis in a stepwise fashion. The variable entered at each step was the one

which provided the greatest improvement in classification. A variable was considered for selection only if its partial multivariate F ratio was larger than 1.0. Table 2 showed the order in which the variables were entered, and the F ratio calculated for each variable as it was entered into the discriminant function.

A review of Table 2 showed that the only statistically significant F ratio was the pre-overall grade point average. After this variable was entered into the discriminant function the discriminating power of the other variables appeared marginal. The cumulative approximate F ratio for the four predictor variables entered into the analysis was 6.79669 (df = 4, 20), which was statistically significant at the 0.01 level.

The prediction equations developed for the predictor variable analysis correctly classified 85.7 per cent of the students who were admitted by pre-selection criteria and 81.8 per cent of the students who were admitted through stratified sampling. The combined prediction accuracy of both equations for the total sample was 84.0 per cent. These data were shown in Table 3.

Table 4 showed the means and the univariate F ratios calculated for the seven predictor variables analyzed for predicting group affiliation between the pre-selected and stratified sample groups. In every instance the means for the pre-selected group were higher than the stratified sample group, as one would anticipate based on the selection process used. Significant univariate F ratios ($p \leq 0.01$) were calculated for pre-professional grade point average and zoology grade point average; as well as a significant univariate F ratio ($p \leq 0.05$) for SCAT total. However, since these variables were not significant on a multivariate

Table 2

INCLUSION OF VARIABLES, BY STEP, PREDICTOR VARIABLE ANALYSIS, 1978 CLASS

Step Number	Variable Entered	F Ratio to Enter (df = 4, 20)
1	V4, Pre-Overall GPA	18.16673*
2	V7, Patient Care Points	1.61274
3	V3, SCAT Total	1.55111
4	V1, SCAT Verbal	2.87329

*($p \leq 0.01$)

Table 3

COMPARISON OF ACTUAL GROUP MEMBERSHIP WITH PREDICTED GROUP MEMBERSHIP, PREDICTOR VARIABLE ANALYSIS, 1978 CLASS

Group	Actual Group Membership	Predicted Group Membership		Per Cent Correctly Classified
		Pre-Selected	Stratified Sample	
Pre-Selected	14	12	2	85.7
Stratified Sample	11	2	9	81.8
Total Correct	25	12	9	84.0

Table 4

COMPARISON OF GROUP MEANS BETWEEN PRE-SELECTED AND STRATIFIED SAMPLE GROUPS; AND UNIVARIATE F RATIO OF PREDICTOR VARIABLES, 1978 CLASS

Predictor Variable	Group Means Pre-Selected	Group Means Stratified Sample	Univariate F Ratio (df = 1, 23)
SCAT Verbal	58.9286	53.0909	0.2258
SCAT Math	75.0000	62.9091	1.4226
SCAT Total	78.0000	60.4545	4.4522*
Pre-Overall GPA	3.5850	3.0300	18.1667**
Pre-Professional GPA	3.5993	3.1036	11.3494**
Zoology GPA	3.7079	2.8755	11.0905**
Patient Care Points	24.4286	19.6364	2.2074

*($p \leq 0.05$) **($p \leq 0.01$)

Table 5

INCLUSION OF VARIABLES, BY STEP, FIRST YEAR GRADES, 1978 CLASS

Step Number	Variable Entered	F Ratio to Enter (df = 3, 21)
1	V4, HRP 431 Grade, The Nervous System	17.48004**
2	V1, HRP 331 Grade, Basic Anatomy and Physiology	3.58797*
3	V2, HRP 332 Grade, Anatomy and Physiology	1.35756

*($p \leq 0.05$) **($p \leq 0.01$)

basis after pre-overall grade point average had been included in the discriminant function, it may be assumed that the variance was accounted by the pre-overall grade point average in the function.

First Year Grade Analysis

The equations developed for the first year grade analysis were as follows:

PS = -33.7739 +6.87638(V1) +2.35516(V2) +9.97556(V4)

SS = -20.54626 +4.13622(V1) +4.02701(V2) +6.72552(V4)

where:

PS = Pre-selected group, 1978 class

SS = Stratified sample group, 1978 class

V1 = HRP 331 grade, Basic Anatomy and Physiology

V2 = HRP 332 grade, Lab, Basic Anatomy and Physiology

V4 = HRP 431 grade, The Nervous System

Table 5 showed the order in which the variables were entered, and the F ratio calculated for each variable as it was entered into the discriminant function.

A review of Table 5 indicated that 2 first year grades, HRP 431 and HRP 331 were statistically significant. After the first two variables were entered into the discriminant function the discriminating power of HRP 332 appeared marginal. The cumulative approximate F ratio for the three first year grades entered into the analysis was 8.25562 (df = 3, 21), which was statistically significant at the 0.01 level.

The prediction equations developed for the first year grades correctly classified 71.4 per cent of the students who were admitted by

pre-selection criteria and 90.9 per cent of the students who were admitted through stratified sampling. The combined prediction accuracy of both equations for the total sample was 80.0 per cent. These data were shown in Table 6.

Table 6

COMPARISON OF ACTUAL GROUP MEMBERSHIP WITH PREDICTED GROUP MEMBERSHIP, FIRST YEAR GRADES, 1978 CLASS

Group	Actual Group Membership	Predicted Group Membership		Per Cent Correctly Classified
		Pre-Selected	Stratified Sample	
Pre-Selected	14	10	4	71.4
Stratified Sample	11	1	10	90.9
Total Correct	25	10	10	80.0

Table 7 showed the means and the univariate F ratios calculated for the eleven first year grades, analyzed for predicting group affiliation between the pre-selected and stratified sample groups. With the exception of PHT 351, Physical Modalities, the means for the pre-selected group were higher than the stratified sample group. Significant univariate F ratios ($p \leq 0.05$) were calculated for HRP 417 (Kinesiology), PHT 332 (Human Anatomy), and HRP 496 (Individual Study). However, since these variables were not significant on a multivariate basis after HRP 431 and HRP 331 had been included in the discriminant function, it may

Table 7

COMPARISON OF GROUP MEANS BETWEEN PRE-SELECTED AND STRATIFIED SAMPLE GROUPS; AND UNIVARIATE F RATIO OF FIRST YEAR GRADES, 1978 CLASS

First Year Course Grade	Group Means Pre-Selected	Group Means Stratified Sample	Univariate F Ratio (df = 1, 23)	Quarter Taught
HRP 331 Grade, Basic Anatomy and Physiology	3.5714	2.7273	13.2662**	1
HRP 332 Grade, Lab, Anatomy and Physiology	3.4286	3.0000	3.5032	1
HRP 417 Grade, Kinesiology	3.5714	2.9091	7.4546*	2
HRP 431 Grade, Nervous System	3.5000	2.6364	17.4800**	2
HRP 433 Grade, Medical and Surgical Disorders	3.5000	3.0909	3.7002	3
PHT 301 Grade, Introduction to P.T.	3.2143	3.0000	0.7785	1
PHT 311 Grade, Cl. Science I	4.0000	3.8182	2.8634	2
PHT 312 Grade, Cl. Science II	3.7857	3.6364	0.6448	3
PHT 332 Grade, Human Anatomy	3.6429	3.0909	5.3133*	1
PHT 351 Grade, Physical Modalities	3.7857	3.8182	0.0249	3
HRP 496 Grade, Individual Study	3.8571	3.3636	5.5124*	1

*($p \leq 0.05$) **($p \leq 0.01$)

be assumed that the variance was accounted by HRP 431 and HRP 331 in the function.

It would appear from the data that HRP 331, a first quarter course, accounted for group discrimination for this quarter; and that HRP 431, a second quarter course, accounted for group discrimination for the second quarter. It was interesting to note that no course offered in the third quarter accounted significantly for distinguishing between groups. This was discussed in the t test for comparison of first, second, and third quarter grade point averages.

3. Stepwise Multiple Regression

A Formula to Predict Grade Point Average, First Year Physical Therapy Curriculum, 1977-1978 Data

This statistical treatment was a stepwise multiple regression procedure which utilized the SPSS computer subprogram REGRESSION, forward (stepwise) inclusion option. The data used consisted of 57 subjects who were admitted to the 1977 class (n = 32) and the 1978 class (n = 25) of the Physical Therapy Curriculum, University of Florida.

The computer program performed a multiple regression analysis with a forward (stepwise) inclusion. The purpose of this procedure was to isolate from the set of five predictor variables, a subset which would yield an optimal prediction equation, with the fewest terms possible, to predict first year grade point average, physical therapy.

The default value was used, which automatically permitted all variables on the predictor list to be used. The F ratio for significance of the regression coefficient was set at 0.01, and the tolerance at

0.001. The variable that explained the greatest amount of variance with the first year grade point average was entered first, the variable that explained the greatest amount of variance in conjunction with the first was entered second, and so on to the fifth variable. If the statistical criteria had not been met, none of the variables would have entered into the regression (Nie et al. 1975).

The prediction equation developed by the stepwise multiple regression analysis was a constant term and a partial regression coefficient for each of the predictor variables of significance.

The equation developed for the prediction of the first year grade point average was as follows:

GPA' = 1.777137 ⁄0.4861478(V2)

where:

GPA' = Predicted first year grade point average, physical therapy

V2 = Pre-overall grade point average

An examination of Table 8 indicated that only the first variable entered, pre-overall grade point average, was statistically significant. The other four variables that were entered into the regression analysis were only marginal. Reference to Table 9 inidcated that the pre-overall grade point average accounted for 24.8 per cent of the first year grade point average. All five predictor variables in the equation account for only 4.5 per cent more variance, or 29.3 per cent total.

Cross-Validation

Reference to the comparison of the 1977 and 1978 groups on the five predictor variables and the criterion variable appear to indicate the

Table 8

INCLUSION OF VARIABLES, BY STEP, 1977-1978 CLASSES, MULTIPLE REGRESSION ANALYSIS

Step Number	Variable Entered	F Ratio (df = 5, 51)
1	V2, Pre-Overall GPA	3.808*
2	V5, Patient Care Points	2.705
3	V1, SCAT Total	0.428
4	V3, Pre-Professional GPA	0.177
5	V4, Zoology GPA	0.173

*($p \leq 0.01$)

Table 9

MULTIPLE REGRESSION STATISTICS, PRE-OVERALL GPA WITH FIRST YEAR GPA, 1977-1978 CLASSES

Multiple R	0.49821
R Square	0.24821
Adjusted R Square	0.23454
Standard Error	0.33534

Variable	B	Beta	Std Error B	F
Pre-Overall GPA	0.4861478	0.49821	0.11408	18.159*
(Constant)	1.1777137			

*($p \leq 0.01$)

comparability of the 1977 and 1978 groups. The combined data for both groups, n = 57, was used to develop the prediction formula GPA' = 1.777137 /0.4861478(V2), where GPA' is the predicted first year grade point average, physical therapy, and V2 is the pre-overall grade point average. A cross-validation technique that was suitable for use with the process model was selected.

The cross-validation statistical analysis was a stepwise multiple regression procedure which utilized the SPSS computer subprogram REGRESSION, forward inclusion. The data used consisted of the same 57 subjects used in the previous multiple regression analysis.

Two new variables were used for this analysis. The first new variable to be used was an effects coding for the year 1977. This was accomplished by assigning the value of "0" to the 1978 year, and the value of "1" to the 1977 year. The variable "year" was assigned the variable label V7. The second new variable to be used was developed by the computer using the COMPUTE transformation control card. The variable label INT1 was assigned the variable, and INT1 = V2*V7 was the variable constructed. Reference to Table 10 showed the mean, standard deviation, and simple r for the variables used in the cross-validation analysis.

Reference to Table 11 showed the conditions for cross-validation of the prediction formula had been met. The pre-overall grade point average was significant; the variables for year, and the interaction of the pre-overall grade point average and year were non-significant; and the r square increase was minimal. It could be concluded that the prediction formula may be used for generalization to the population.

Table 10

MEAN, STANDARD DEVIATION, AND CORRELATION MATRIX OF VARIABLES, 1977-1978 CLASSES, MULTIPLE REGRESSION ANALYSIS

	V1	V2	V3	V4	V5	V6	Mean	N
V1	1.00000	0.07759	0.12090	0.35764	-0.37039	0.03097	66.9123	57
V2		1.00000	0.83753	0.56104	0.08100	0.49821	3.3205	57
V3			1.00000	0.57368	0.03591	0.43644	3.2863	57
V4				1.00000	-0.16247	0.22765	3.2468	57
V5					1.00000	0.22824	21.4211	57
V6						1.00000	3.3914	57
SD	25.1952	0.3928	0.4625	0.7994	8.8155	0.3833		

Table 11

MULTIPLE REGRESSION STATISTICS, PRE-OVERALL GPA, 1977 YEAR, AND GPA*YEAR WITH FIRST YEAR GPA, 1977 CLASS

Multiple R	0.52419
R Square	0.27478
Adjusted R Square	0.23373
Standard Error	0.33552

Variable	B	Beta	Std Error B	F
V2, Pre-Overall GPA	0.5376734	0.55101	0.16181	11.042*
V7, 1977 Year	0.2704548	0.35325	0.76464	0.125
INT1, GPA*YEAR	-0.1163879	-0.50941	0.22853	0.259
(Constant)	1.670141			

*($p \leq 0.01$)

4. t Test--
Comparison Between Pre-Selected and Stratified Sample Groups, 1978, with Three Criteria Variables

This statistical treatment was a t test of significance which utilized the SPSS computer subprogram T-TEST, group comparison of means for the criteria variables first, second, and third quarter grade point averages. It was a test between the pre-selected group and the stratified sample group, the two groups in the 1978 class.

The values of the t test analysis, with pooled variance estimates for the pre-selected and stratified sample groups with the three variables first, second, and third quarter grade point averages were shown in Table 12. The table included the means, standard deviations, and the number of subjects in each group used in the analysis of each variable.

A comparison of the means by student t tests pointed up significant differences ($p \leq 0.01$) between the two groups with respect to the first quarter GPA, and the second quarter GPA. There was no significant difference between the two groups with respect to the third quarter grade point average.

This analysis, in conjunction with the discriminant analysis, may have indicated a trend in the data. In the multivariate analysis two courses, one in the first quarter, and another in the second quarter, accounted for significant differences between the two groups in the discriminant function. The fact that no difference occurred in any individual course, or between the total groups in the third quarter, suggested that the groups had begun to achieve at comparable levels.

Table 12

t TEST VALUES, GROUP DIFFERENCES OF FIRST, SECOND, AND THIRD QUARTER GPA, P.T., FOR PRE-SELECTED AND STRATIFIED SAMPLE GROUPS, 1978 CLASS

Criterion Variable	n	Mean	Standard Deviation	df	t
First Quarter GPA					
Pre-Selected	14	3.4779	0.453	23	-3.16*
Stratified Sample	11	2.9227	0.413		
Second Quarter GPA					
Pre-Selected	14	3.7307	0.274	23	-4.44*
Stratified Sample	11	3.1718	0.357		
Third Quarter GPA					
Pre-Selected	14	3.7000	0.364	23	-1.11
Stratified Sample	11	3.5418	0.341		

*($p \leq 0.01$)

5. The Stratified Sample Process Model

The admission procedure, to be successful, should follow an orderly process. This is especially necessary when one is to use a new admission procedure such as has been involved in this study. To those who decide to use the stratified sampling procedure as part of their admission process, proper replication, or reliability, requires there be standardization in the approach used. It is, therefore, necessary that a process model be developed. To that objective the following process model, incorporating the ideas of stratified sampling, has been developed.

Stratified Sample Process Model Criteria

The stratified sample process model should be

1. Based on sound statistical premise.
2. Able to be used on a continuing basis.
3. Simple and practical to use.
4. Compatible with most computer hardware and software in institutions of higher education.
5. As brief as possible, without effecting quality.
6. Logical and follow a sequential pattern.
7. Presented in a clear and unambiguous manner.
8. Able to develop the least number of predictor variables to account for the maximum variance with the criterion variable.

Application of the Stratified Sample Process Model

1. Establish the total number to be in the new class.
   A. Determine the total number of applicants to be admitted.

B. Determine the number of applicants to be chosen by pre-selection in the new class. They should be approximately 50 per cent of the class.

C. Determine the number of applicants to be selected by stratified sampling. They should be approximately 50 per cent of the class.

2. Establish a cut-off point for consideration for pre-selection and inclusion in stratified sample pool.

A. Develop a prediction formula with the criterion variable, first year grade point average, physical therapy.

a. Data to be used are the two classes immediately preceding the new class to be formed.

b. Use SPSS computer subprogram REGRESSION, stepwise forward multiple regression procedure. Use predictor variables for prior two classes, or revised predictors, whichever is applicable.

B. Cross-validate prediction formula with prior year's class (Note: New predictors cannot be validated until the end of the first year).

C. Use validated prediction formula for use in selecting new class.

a. Ordinally rank top n for pre-selection group.

b. With minimum criterion variable established as cut-off point establish stratified sample pool. Randomly sample for desired n.

c. When establishing the stratified sample pool, it is important the pool be as large as possible without

jeopardizing the criterion that the students selected have an equal chance to complete their first year's study without failing. The standard error term, see Table 9, should be considered in establishing the criterion variable of predicted first year grade point average.

3. Identify the new class data and the prior year class data for comparison of predictor variables.

   A. Use SPSS subprogram T-TEST to compare group means of predictor variables for significance. There should be no significant differences, in order to continue. If the two groups are not comparable a change in selection may have taken place and must be identified, and corrected if necessary, before continuing with new class finalization. Allow for chance probability in analysis if only one predictor variable is involved.

4. Continue analysis of predictor variables for identifying group affiliation with pre-selected and stratified sample groups in new class.

   A. Use SPSS subprogram DISCRIMINANT, stepwise, using Wilk's lambda method.

   B. Develop prediction formulas for group affiliation based on the best predictors, using a multivariate analysis. Two analyses are conducted. The first is with the predictor variables which are significant for predicting group affiliation to the general population. The second analysis is

for a significant cumulative approximate F ratio which accounts for the new class group affiliations.

a. Using group affiliation prediction formulas identify the pre-selected and stratified sample groups.

b. Determine the accuracy of the predictions.

c. The information developed is used in the feedback loop to continue or modify the predictor variables for use in the next year's class.

5. At the conclusion of the first year in professional school analyze the criteria variables, individual grades, for significance in identifying group affiliation for pre-selected and stratified sample groups.

A. Use SPSS subprogram DISCRIMINANT, stepwise, using Wilk's lambda method.

B. Develop prediction formulas for group affiliation based on the best criteria variables, using a multivariate analysis. Two analyses are conducted. The first is those criteria variables which are significant for predicting group affiliation based on achievement. The second analysis is for a significant cumulative approximate F ratio which accounts for the new class group affiliations.

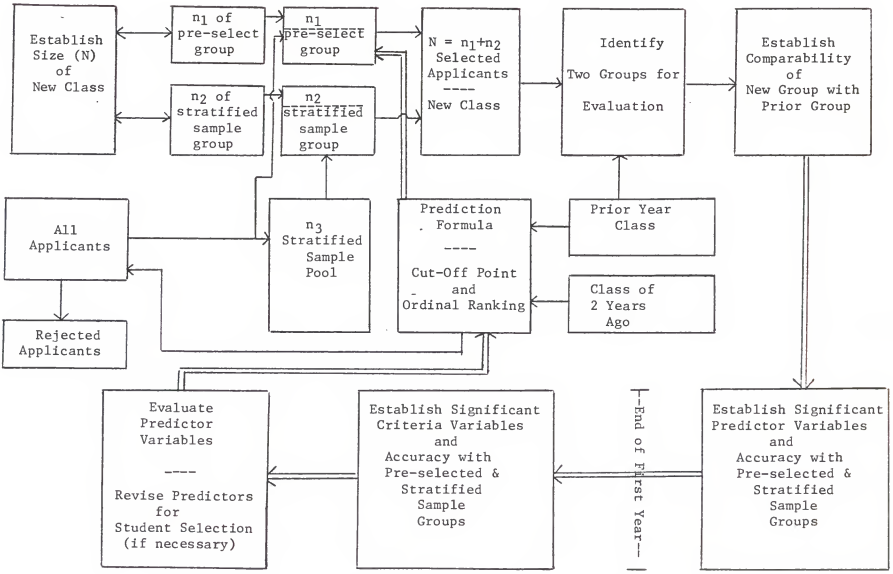
a. Using group affiliation prediction formulas identify the pre-selected and stratified sample groups.

b. Determine the accuracy of the predictions.

c. The information developed is used for determining the trends of performance for the new class, particularly as to their common achievements, as well as the

distinguishing characteristics of the groups. This is used as an aid to curriculum planning for the professional development toward clinical goals of each group of applicants.

6. Using the results of the prediction formula for developing the cut-off point, and the identification of the best predictors for group affiliation, determine if the predictors being used are effective in establishing the cut-off point. Basically there should be a minimum of three predictors: one for aptitude, one for prior overall grade point average, and one for affective evaluation of the applicant (i.e., interest, motivation, and similar factors, using Q-Sort, or Biographical Inventory). If weighting coefficients are not significant different predictors may be considered at this point, and used for the evaluation with the next class to be admitted.


Establish Size (N) of New Class
n_1 of pre-select group
n_1 pre-select group
n_2 of stratified sample group
n_2 stratified sample group
N = n_1+n_2 Selected Applicants
New Class
Identify Two Groups for Evaluation
Establish Comparability of New Group with Prior Group
All Applicants
n_3 Stratified Sample Pool
Prediction Formula
Cut-Off Point and Ordinal Ranking
Prior Year Class
Class of 2 Years Ago
Rejected Applicants
Evaluate Predictor Variables
Revise Predictors for Student Selection (if necessary)
Establish Significant Criteria Variables and Accuracy with Pre-selected & Stratified Sample Groups
End of First Year
Establish Significant Predictor Variables and Accuracy with Pre-selected & Stratified Sample Groups

THE STRATIFIED SAMPLE PROCESS MODEL FLOW CHART

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

There were two purposes for this study. The first was to determine if a first year class of physical therapy students partially selected by stratified sampling was compatible with the remainder of the same class chosen by ordinal rank pre-selection, using established predictor variables. The second purpose was to develop a process model which could be used to evaluate future data of a similar type; as well as to improve the predictor variables if changes in these variables were necessary to improve the selection process involving stratified sampling.

The 1978 test group, approximately half selected by stratified sampling and the other half by ordinal rank pre-selection, was compared to the 1977 class completely chosen by ordinal rank pre-selection. Both classes were chosen using the predictor variables of SCAT total, pre-overall grade point average, pre-professional grade point average, zoology grade point average, and patient care points. The data were also available for first year grade point average in the physical therapy program. A t test to compare group means with the six variables was conducted using the SPSS subprogram T-TEST and no significant differences were found, thus establishing the apparent comparability of the two groups.

The relationship of seven predictor variables and eleven achievement variables to the group affiliation of the physical therapy class of 1978 were analyzed by two separate stepwise discriminant analyses, which used the SPSS computer subprogram DISCRIMINANT. The computer program developed sets of equations for predicting either (1) affiliation with the pre-selected group, or (2) affiliation with the stratified sample group. The computer program was set up so that at each step the variable entered was the one that provided the greatest improvement in classification between the pre-selected students, and the students chosen by stratified sampling.

The prediction equations developed for the predictor variable analysis entered the variables in the following order:

1. Pre-overall grade point average.
2. Patient care points.
3. SCAT total.
4. SCAT verbal.

The only significant F ratio was the pre-overall grade point average, with the other variables only having marginal discriminating power after they were entered into the discriminant function. The cumulative approximate F ratio for the four predictor variables was significant to the 0.01 level.

The prediction equations developed for the predictor variable analysis correctly classified 85.7 per cent of the students who were admitted by the pre-selection criteria and 81.8 per cent of the students who were admitted through stratified sampling. The combined prediction accuracy of both equations for the total sample was 84.0 per cent.

The prediction equations developed for the eleven achievement variable analysis, i.e., the first year course grades, entered the variables in the following order:

1. HRP 431 grade, the Nervous System.
2. HRP 331 grade, Basic Anatomy and Physiology.
3. HRP 332 grade, Lab, Basic Anatomy and Physiology.

The first variable, HRP 431 grade, was significant at the 0.01 level, and the second variable, HRP 331 grade, was significant at the 0.05 level. The third variable only had marginal discriminating power after the first two variables were entered into the discriminant function. The cumulative approximate F ratio for the three first year course grade variables was significant at the 0.01 level.

The prediction equations developed for the first year courses correctly classified 71.4 per cent of the students who were admitted by pre-selection criteria, and 90.9 per cent of the students who were admitted through stratified sampling. The combined prediction accuracy of both equations for the total sample was 80.0 per cent.

Using the data for the 1977 and 1978 classes a stepwise multiple regression, using SPSS computer subprogram REGRESSION, was performed to isolate from the set of five predictor variables, a subset which would yield an optimal prediction equation, with the fewest terms possible, to predict first year grade point average in physical therapy.

The equation developed for the prediction of the first year grade point average entered the variables in the following order:

1. Pre-overall grade point average.
2. Patient care points.
3. SCAT total.

4. Pre-professional grade point average.

5. Zoology grade point average.

The only significant F ratio was the pre-overall grade point average, with the other variables only having marginal value. A cross-validation with the 1977 year indicated the validity of the prediction formula using the pre-overall grade point average as the sole predictor variable.

A comparison of the group means of the first, second, and third quarter grade point averages, using the SPSS computer subprogram T-TEST, was performed with the pre-selected and stratified sample groups. There was a significant difference between the two groups with respect to the first and second quarter grade point averages, at the 0.01 level, but no difference in the third quarter grade point average. This finding, combined with the discriminant function analysis finding, suggested that the groups had begun to achieve at comparable levels in the third quarter.

Based on the experience with the 1978 class, a process model was developed. The basis of the model was the data and experience with the stratified sample and pre-selected groups of the 1978 class. The results of the study indicated a need to develop new predictor variables. The model accounted for a process which included the selection of pre-selected and stratified sample groups, the multivariate computer subprograms for establishing the cut-off point and significant predictor variables for group affiliation, the evaluation of first year achievement relative to group affiliation, and an evaluation procedure for maintaining, or selecting, new predictor variables for the next class to be admitted.

Conclusions

A review of the findings suggested the following conclusions:

1. Prior overall grade point average was the single most powerful predictor of academic performance during the first year in the physical therapy curriculum and the most important discriminator between the pre-selected and stratified sample groups. There was no indication for the continued use of the other predictor variables used in this study.

2. There were more similarities than differences between the pre-selected and stratified sample groups in their achievement during the first year. Two subjects maximally discriminated between the pre-selected and stratified sample groups. The course HRP 331, Basic Anatomy and Physiology, taught during the first quarter, and HRP 431, the Nervous System, taught the second quarter accounted for the majority of variance associated with group discrimination. Both of these were highly cognitively oriented courses. The third quarter courses were essentially clinically oriented. The fact that no significant difference was shown during the third quarter tended to indicate that the two groups came closer together as they advanced in the academic program.

3. The findings in this study tended to support the continued use of stratified sampling in the admission of physical therapy students. There were no statistics to demonstrate any basic difference between the composition or progress of the 1978 class admitted with part of the class chosen by stratified sampling, and the 1977 class chosen completely by pre-selection.

4. Based on the data and findings of the study a process model was designed. It was possible to design a process model that could account

for the procedures leading to the study, the study itself, and to future admissions using pre-selected and stratified sample groups. The process model was based on the systems approach and had designed into it an evaluation feedback procedure to update the process as changes were indicated. A SPSS computer program was incorporated into the model, and all the data to be analyzed were accomplished with three subprograms in the SPSS package.

Recommendations

Based on the findings of the study and the review of the literature, the following are recommended:

1. New predictor variables should be explored. It would appear three variables would suffice for selection in physical therapy. This study has demonstrated, as have most other studies, that the overall grade point average prior to admission is a powerful predictor variable. The overall grade point average prior to admission should, therefore, be one of the three variables used.

Reading comprehension and research of the literature are important skills the physical therapy student must have to achieve in the physical therapy curriculum. It is, therefore, recommended that the second predictor variable be the Library Orientation Test (Corlett 1974).

The third predictor variable should be a non-cognitive predictor. The quantifying of this predictor may be accomplished by either the Q-Technique (Trotter and Fordyce 1975), or the Biographical Data Inventory (Blume 1976).

2. The stratified sample pool should be made as large as practical to give every qualified applicant an equal chance of being selected. Since HRP 331 and HRP 431 appear to be the courses differentiating the pre-selected and stratified sample groups, consideration should be given to remedial instruction for these two courses, using either self-instruction or peer-mediated techniques. This will permit a lower cut-off point, thus enlarging the stratified sample pool.

3. Stratified sample admissions offer an alternative procedure to the quota system as used in the Bakke case, a case of alleged reverse discrimination currently before the Supreme Court of the United States (1977). Kurlund (1968) advocated the use of stratified sampling as a means of selecting candidates with certain desirable characteristics. In the case of minority admissions one is seeking certain characteristics such as special language, experience, and developmental factors to meet the needs of minority patients. It is conceivable, therefore, rather than limiting this group to minority applicants it can be opened to any candidate providing the qualifications for working with minority patients. While this category may have predictor variables which favor minority applicants, it would not preclude non-minority applicants from being placed in this pool, and thus would appear to overcome the quota system in question in the Bakke case.

4. Further research should be considered in the following areas:

   A. Establishing the best ratio between the pre-selected and the stratified sample groups.

   B. Replication and validation of the current study with a larger N.

C. A five-year longitudinal study of the 1978 class after graduation, to compare the progress of the pre-selected and stratified sample groups. In the study, consideration should be given to the length of employment, the type of positions held, the performance rating by supervisors, where the graduates are practicing, the contribution of the graduates to the field of physical therapy, and to a non-cognitive evaluation of the graduates.

APPENDICES

APPENDIX A

COMPUTER CARD DATA CODING

Column	Item
01-02	SCAT Verbal
03-04	SCAT Math
05-06	SCAT Total
07-10	Pre-Overall Grade Point Average
11-14	Pre-Professional Grade Point Average
15-18	Zoology Grade Point Average
19-20	Total Patient Care Points
21-24	First Quarter Grade Point Average, Physical Therapy
25-28	Second Quarter Grade Point Average, Physical Therapy
29-32	Third Quarter Grade Point Average, Physical Therapy
33-36	First Year Grade Point Average, Physical Therapy
37	HRP 331 Grade, Basic Anatomy and Physiology Coding: (Columns 37-47) A = 4, B = 3, C = 2, D = 1
38	HRP 332 Grade, Lab, Basic Anatomy and Physiology
39	HRP 417 Grade, Kinesiology
40	HRP 431 Grade, The Nervous System
41	HRP 433 Grade, Medical and Surgical Disorders
42	PHT 301 Grade, Introduction to Physical Therapy
43	PHT 311 Grade, Clinical Science 1
44	PHT 312 Grade, Clinical Science 2
45	PHT 332 Grade, Human Anatomy
46	PHT 351 Grade, Physical Modalities

Column	Item
47	HRP 496 Grade, Individual Studies
48	Year, 1 if 1977, 0 if 1978
49	Group Affiliation: Pre-Select = 1; Stratified Sample = 0.

APPENDIX B

EXAMPLES OF DECK SETUP, SPSS PROGRAM

t Test

```
1                   16
RUN NAME            T-TEST COMPARISON, 1977-1978 GROUPS
VARIABLE LIST       V1 TO V6
INPUT MEDIUM        CARD
N OF CASES          57
INPUT FORMAT        FIXED(T5,F2.0,3F4.0,F2.0,T33,F4.0)
VAR LABELS          V1 SCAT TOTAL/V2 POGPA/V3 PPGPA/V4 ZOOGPA/V5 PT CARE PTS/
                    V6 1ST YR GPA
T-TEST              GROUPS = 25,32/VARIABLE V1 TO V6
READ INPUT DATA     (Data for 57 Cards)
```

Discriminant Analysis

```
1                16

RUN NAME         DISCRIMINANT ANALYSIS, 1978 GROUP, INDEPENDENT VARIABLES

VARIABLE LIST    Y V1 TO V7

INPUT MEDIUM     CARDS

N OF CASES       25

INPUT FORMAT     FIXED(T49,F1.0,T1,3F2.0,3F4.0,F2.0)

VAR LABELS       V1 SCAT VERBAL/V2 SCAT MATH/V3 SCAT TOTAL/V4 POGPA/
                 V5 PPGPA/V6 ZOOGPA/V7 PT CARE PTS/Y 0&1  0 = STRATIFIED
                 SAMPLE

DISCRIMINANT     GROUPS=Y(0,1)/VARIABLES=V1 to V7/
                 ANALYSIS=V1 TO V7
                 ANALYSIS=V1 TO V7 (7)
                 METHOD=WILKS

STATISTICS       1,2,3,4,6,7,8,9

OPTIONS          5,6,7,11,12

READ INPUT DATA (Data for 25 Cards)
```

Multiple Regression Analysis

```
1               16
RUN NAME        MULTIPLE REGRESSION, 1977-1978 GROUPS
VARIABLE LIST   V1 TO V6
INPUT MEDIUM    CARD
N OF CASES      57
INPUT FORMAT    FIXED(T5,F2.0,3F4.0,F2.0,T33,F4.0)
VAR LABELS      V6 1ST YR GPA/V1 SCAT TOTAL/V2 POGPA/V3 PPGPA/V4 ZOOGPA/
                V5 PT CARE PTS
REGRESSION      VARIABLES=V1 TO V6
                REGRESSION=V6 WITH V1 TO V5 (3)/
STATISTICS      1,2
READ INPUT DATA (Data for 57 Cards)
```

Cross-Validation for Multiple Regression Analysis

```
1               16
RUN NAME        MULTIPLE REGRESSION, CROSS VALIDATION, 1977 GROUP
VARIABLE LIST   V2 V6 V7
INPUT MEDIUM    CARD
N OF CASES      57
INPUT FORMAT    FIXED(T7,F4.0,T33,F4.0,T48,F1.0)
VAR LABELS      V2 POGPA/V6 1ST YR GPA/V7 YEAR, 0 = 1978, 1 = 1977
COMPUTE         INT1 = V2*V7
REGRESSION      VARIABLES=V2 V6 V7 INT1/
                REGRESSION=V6 WITH V2(6) V7(4) INT1(2)/
STATISTICS      1,2
READ INPUT DATA (Data for 57 Cards)
```

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BIOGRAPHICAL SKETCH

Harold Shalik was born February 5, 1927, at New York, New York. He attended public schools in Brooklyn, New York, and graduated from Metropolitan Vocational High School, New York City, in 1945. From February 1945 to September 1946, he was on active duty with the U.S. Maritime Service as a radio officer. Upon his return he entered Brooklyn College, October 1946. He transferred to the Columbia University School of Occupational Therapy in September 1950, and received the Bachelor of Science degree in occupational therapy February 1953.

Upon graduation he became director of occupational therapy at the newly opened Iowa Vocational Rehabilitation Center, Des Moines, Iowa. One year later he transferred to the Veterans Administration Hospital, Knoxville, Iowa. He remained with the Veterans Administration from April 1954 through September 1964. In 1955, he transferred to the Veterans Hosiptal, Bedford, Massachusetts, as chief of occupational therapy, and held a similar position at the Veterans Hospital, Coral Gables, Florida, from 1959 to 1964.

From 1964 to 1975, he was in part-time private occupational therapy practice and was self-employed in a rehabilitation mail order business. He entered Graduate School of the University of Florida in March 1975. He received the Master of Education degree in 1976, with a major in health occupations education. Since that date he has been studying toward the Doctor of Philosophy degree in curriculum and instruction.

From his marriage to the former Loretta Mae Milefchik of Pocahontas, Iowa, they have two children, a daughter Karen, and a son Kenneth.

He is a member and a registered occupational therapist with the American Occupational Therapy Association since 1953, and a licensed occupational therapist in the State of Florida since 1976.

I certify that I have read this study and in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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Professor of Curriculum and Instruction

I certify that I have read this study and in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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Associate Professor of Curriculum and Instruction

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March 1978

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